HYDRO-ELECTRIC POWER COMMISSION

of the

Province of Ontario

FIFTH REPORT

ALGOMA, THUNDER BAY AND RAINY RIVER DISTRICTS

Printed by Order of the Legislative Assembly of Ontario.
March 15th, 1907

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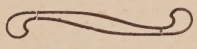

FIFTH REPORT

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COMMISSION

HON. ADAM BECK, London, Chairman.

GEO. PATTINSON, M.P.P., Preston.

JOHN MILNE, Hamilton.

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CECIL B. SMITH... ... .*Chief Engineer.*

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W. G. CHACE.....*Asst. Engineer.*

S. B. CLEMENT.....*Asst. Engineer.*

E. RICHARDS.....*Electrical Engineer.*

A. D. GRIFFIN .....*Field Engineer.*

F. W. WILKINS .....*Field Engineer.*

G. T. JENNINGS .....*Field Engineer.*

E. C. SETTELL.....*Secretary.*

FIFTH REPORT.

ALGOMA, THUNDER BAY AND RAINY RIVER DISTRICTS.

To His Honour,
The Lieutenant-Governor of Ontario:—

The undersigned Commissioners appointed by Your Honour by Commission bearing date the 26th day of January, 1906, beg leave to submit the following as their fifth report upon the matters authorized and directed to be enquired into.

Your Commissioners caused enquiries to be made and information to be obtained from various sources, but did not hold formal sittings in those districts, as the information which was desired for the purposes of this report has been given freely to members of their engineering staff, who have thoroughly canvassed those districts both as to their hydraulic possibilities and present industrial demands.

During the summer of 1906, the members of the Commission, at that time, visited Port Arthur, Fort William and Kenora and examined the water powers and enquired into the conditions at these places.

The Engineers' reports indicate the great hydraulic potentialities of this portion of the Province, and your Commissioners desire to emphasize the value which these water powers have, owing to the wide district traversed by them, in relation to the future development of the timber and mineral resources of those districts. The detailed scientific and technical information has been obtained at considerable expense and under great difficulties, owing to the rugged natural conditions and unsettled parts through which most of the rivers of those districts flow; it has been tabulated and arranged by the Engineer employed by your Commissioners and is contained in his fifth report, which is submitted as an appendix hereto.

The following are the matters on which your Commissioners were authorized and directed to enquire, with the report upon each subjoined:—

DEMAND FOR ELECTRIC POWER.

(1) -"*The present and probable demand for hydraulic and electrical power in the various districts capable of being supplied from the different water powers within the jurisdiction of the Province of Ontario.*

In this fifth report your Commissioners deal in general with that portion of Ontario comprising the judicial districts of Algoma, Thunder Bay and Rainy River, but have omitted that area north of the height of land owing to the sparseness of population and lack of demand for power in this region. Within the near future with the construction of the Transcontinental, Temiskaming and other railways, it may become advisable to make a fuller investigation of this area.

Many towns have been located at the conjunction of railway and water powers. Of these, we may mention Kenora, Fort Frances and Sault Ste. Marie. The prosperity these places have attained is largely due to the development of hydraulic power.

The demand for electrical power will, in almost all cases, depend upon the relative cost of electricity as compared with that of steam, gas or other power. The cost of electricity is dependant upon the distance over which it is transmitted and upon the quantity transmitted. As it is only feasible to transmit the power in large quantities, trunk transmission lines capable of carrying large quantities must be constructed at the outset; therefore, the cost increases with the distance, and a point is eventually reached at such a distance from the generating station that electrical can no longer compete with steam or other power.

It is an interesting fact, however, that at Port Arthur and Fort William, where coal is laid down at a very moderate rate, water-powers have been developed somewhat commensurate with the present requirements, and to such an advantage that a strong feeling exists for increasing the supply of electrical energy by further developments.

The exhaust steam and heat from the steam plants of some factories is used in the process of manufacture and for heating purposes, which will prevent the adoption of electrical power in some cases, as the cost of steam and heat for manufacturing purposes, apart from power, would increase rather than diminish the expense.

Also in many instances waste material is used in the production of steam; such industries have not been included in the consideration of the extent of the market at present in sight. The capital cost of abandoning steam plants would also, in many cases, be considerable, and the ability of small users of power to bear this loss must always be a factor in the finding of a market.

As a result of your Commissioners' enquiries in the various towns and villages of these districts as to the present market for electrical power, it would appear that outside of the Victoria Mines, in the vicinity of which there is a completed development which is not at present utilized, there are only two markets at present open for supply, though these may be augmented by future demands of mines, mills, pulp-factories, etc. These are Thessalon and Bruce Mines, which can be supplied from the Mississauga River to at least the present demand of 150 H.P. and 500 H.P. respectively, and Port Arthur, which can supplement its present supply of 1,000 H.P., derived from its municipal water power, by the transmission of any quantity of power from the Nepigon or Kaministiquia Rivers.

In the opinion of your Commissioners, the outlook for a plentiful supply of electrical power at moderate rates will be of very great value in the establishment of industries at Port Arthur and Fort William, and as the Kaministiquia Power Co. has already a development delivering power to the latter city, it has been considered sufficient to indicate, by two estimates, the manner in which power may be most economically supplied to Port Arthur in any quantity likely to be required in the near future with the development of the mineral resources of Northern Ontario. It may be confidently anticipated, however, that the water powers adjacent to these mines will be utilized to supply the power required.

UNDEVELOPED LOCATIONS.

(2) *"The location, capacity and capital cost of development of the various water powers within the legislative jurisdiction of the Province of Ontario at present undeveloped, but whose development is required to supply the present and probable needs of the surrounding districts, and to ascertain the cost of the attendant transmission plant necessary to the utilization of electrical and hydraulic powers to be provided from the aforesaid water powers within the respective surrounding districts."*

A systematic tabulation of the water powers of the various rivers in this district based upon gaugings and meterings, supplemented by information derived from other sources, has been carried out during the past eighteen months, and although more minute information, particularly with reference to dry-weather flow, could be obtained by continuing the work, it is felt that a fairly accurate hydraulic knowledge of these districts has been obtained.

The natural storage of many of the rivers of these districts is very good, but in nearly all instances still better conditions can be obtained by placing dams at the various lake outlets and holding water back for use during the dry season.

The Spanish, Vermilion, Onaping, Mississauga, Serpent, Michipicoten, White, Black Sturgeon, Kaministiquia, Seine and Rainy Rivers are all capable of excellent storage regulation and the waste land, which would be flooded by such action, would be of a rocky character, having little present value. The Nepigon River is so extensive and the lake storage so enormous that it is not probable that any scheme of increasing its storage would be advisable.

The Dog Lake development, estimated at 14,000 H.P., can at a comparatively small expense, be doubled in capacity by a dam at the mouth of the lake and proper control of storage secured for a depth of 10 feet.

Your Commissioners having considered Port Arthur's present and probable future requirements, have made two estimates for supplying the same, and in Part IV. of the first appendix will be found estimates of the cost of alternative developments for supplying these requirements, and also to supply those of Bruce Mines and Thessalon from a source on the Mississauga River. Tables IV. and V. give estimates of capital cost and yearly charges on generating plant.

RATES AND PRICES.

(3) *"To ascertain the rates or prices that would require to be charged the various classes of consumers of hydraulic or electrical power within the respective districts in order to meet all expenditure of maintenance and operation."*

The ascertainment of the rates that would require to be charged for electrical power in order to meet expenditure of maintenance and operation is based upon the cost of necessary plant for future

calls upon it, original cost of construction, cost of maintenance and operation, and the probable market for electrical power, ascertained from local enquiries.

In order to ascertain the cost of delivering power to Port Arthur, Bruce Mines and Thessalon, your Commissioners have caused computations to be made for transmission systems and sub-stations for supplying and delivering the power generated at power stations on the Kaministiquia, Nepigon and Mississauga rivers, and in Part V. of the first appendix will be found the necessary calculations, based on delivering 6,000 to 14,000 H.P. at Port Arthur either from the Kaministiquia or Nepigon rivers, and to deliver 150 H.P. at Thessalon and 1,650 H.P. or 3,300 H.P. at Bruce Mines. This should meet future requirements for some time to come.

Your Commissioners call attention to the fact that when electricity is delivered at municipal sub-stations the cost of distribution to consumers within such municipality must be added to this price in order to determine the cost to the individual municipal consumer.

Table X., Part V., also gives data in regard to the cost of supplying a particular customer with power at a considerable distance from a sub-station, the total cost to such a consumer being the sub-station cost added to the secondary cost given in this table.

POWER SUPPLIED AND UNDER CONTRACT BY THE EXISTING COMPANIES.

(a) *"The quantities supplied and contracted for and the rates charged and to be charged under such contracts by these companies for hydraulic and electrical power."*

In Part III. of the first appendix, Table III., and Part IV. of the second appendix will be found listed the amount of machinery installed at various points. It will be noted that pulp grinding, flour grinding and mining operations constitute the present power market.

The prices or rates charged for power and light in various municipalities are given in Table XII of the first appendix, and the Kenora rates are given in Part IV. of the second appendix.

The difference in prices charged for power and light at Sault Ste. Marie and Kenora is very great, though the conditions are similar, in that both are free from long-distance transmission.

Your Commissioners believe that this and preceding reports cover the whole of the Province with the exception of the James Bay watershed. In making investigations, they have endeavored to get a survey of all important waters, so that the department might have on file particulars of the immense hydraulic resources available.

Your Commissioners desire to express their appreciation of the services rendered by the Chief Engineer and the Assistants associated with him in carrying out their portion of the work. The surveying and measuring of the streams, especially in the northern part of the Province, has called for much arduous work, which necessarily had to be performed under the most difficult conditions.

APPENDIX

TO

FIFTH REPORT

Algoma and Thunder Bay Districts.

ENGINEER'S REPORT

ON

THE WATER POWERS AND ON THE GENERATION AND TRANSMISSION OF ELECTRIC POWER GENERATED THEREFROM.

HONOURABLE ADAM BECK,

CHAIRMAN OF THE HYDRO-ELECTRIC POWER COMMISSION:

DEAR SIR,—

Herewith find my report on Algoma and Thunder Bay Districts, extending northward to the height of land and westward so as to include all of the watershed in the Province of Ontario draining into Lake Superior and Lake Huron.

The report deals with the present consumption of and demand for power, the sources of power developed or undeveloped and discusses in detail certain developments within economical transmission distance of various present markets and indicates the cost of generating and transmitting electrical energy necessary to meet the present requirements, based on 4 per cent. return on investment.

Yours Respectfully,

CECIL B. SMITH,

Chief Engineer.

TORONTO, CANADA,

MARCH 15TH, 1907.

FIFTH REPORT.

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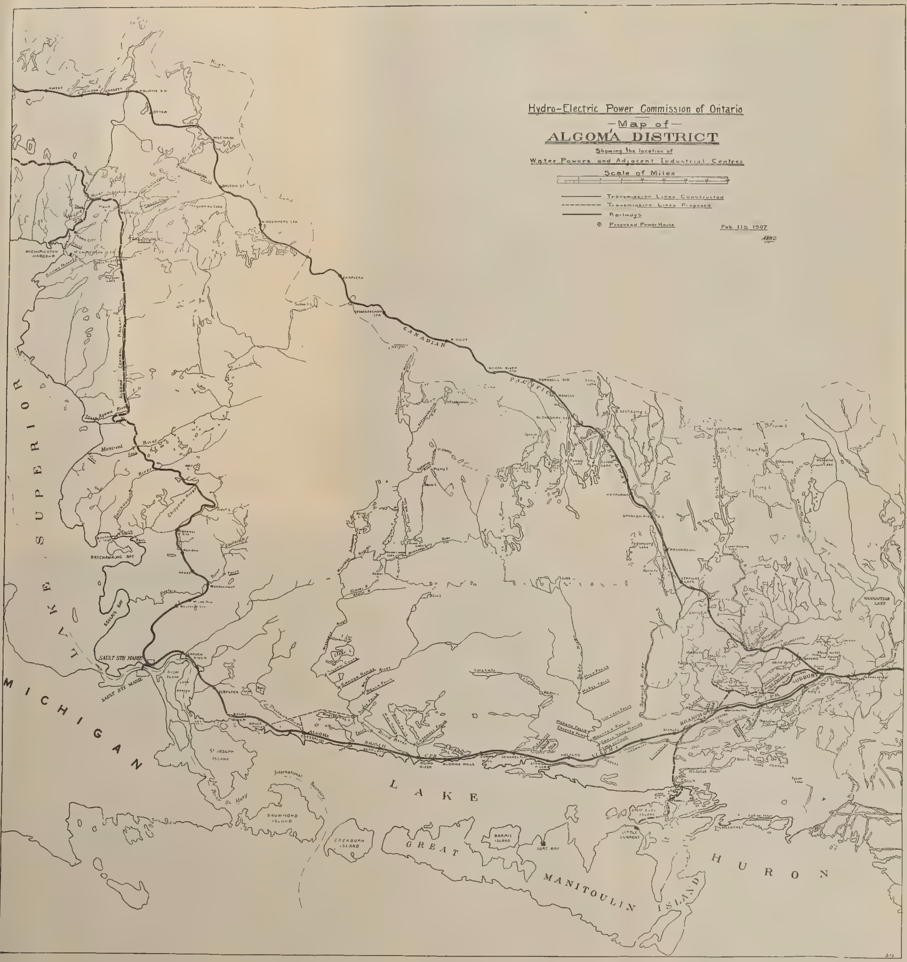

Hydro-Electric Power Commission of Ontario
—Map of—
ALGOMA DISTRICT
Showing the location of
Water Powers and Adjacent Industrial Centres
Scale of Miles
Transmission Lines Constructed
Transmission Lines Proposed
Railways
Proposed Power House
Feb. 11th 1907
LAKE SUPERIOR
MICHIGAN
LAKE HURON
GREAT MANITOULIN ISLAND
CANADIAN PACIFIC
ALGOMA CENTRAL RAILWAY
ALGOMA BRANCH
SAULT STE MARIE
MICHIPICOTON HARBOUR
CHAPLEAU
SUDBURY
BATCHAWANA BAY
GOULAIS BAY
ST JOSEPH ISLAND
DRUMMOND ISLAND
COCKBURN ISLAND
BARRIE ISLAND
GORE BAY
LITTLE CURRENT
ALGOMA MILLS
International Boundary
River St Mary
Montreal River
Chippewa River
Spanish River
Blind River
Agawa River


Hydro-Electric Power Commission of Ontario
—Map of—
THUNDER BAY DISTRICT
Showing the location of
Water Powers and Adjacent Industrial Centres
Scale of Miles
Transmission Lines Constructed
Transmission Lines Proposed
Railways
Proposed Power House
Jan 21st 1907
Height of Land
LAKE NEPIGON
Elevation 800 ft
NEPIGON BAY
BLACK BAY
THUNDER BAY
PORT ARTHUR
FORT WILLIAM
LAKE SUPERIOR
Elevation 600 ft
ONTARIO
MINNESOTA

PART I.

GEOGRAPHICAL SUBDIVISIONS.

This report deals with the Hydro-Electric conditions and present power requirements of that portion of the Province lying along the north shores of Lake Huron and Lake Superior, south of the height of land. This extensive territory is, to a large extent, unsettled and in many localities practically unexplored, but it has been determined that water powers capable of economical development, having an output far in excess of all present requirements, are distributed over its whole area.

Speaking generally, all the important water powers lying within the zone of influence of the Canadian Pacific, Algoma Central and Canadian Northern Railways, have been carefully examined in detail, but somewhat more general information concerning the more remote power sources of this territory has been considered sufficient, as surveys would have entailed an amount of investigation not warranted by present need.

The territory covered by this report includes two distinct drainage areas, of which the more easterly is that drained by Lake Huron. The portion of this to be considered extends west from Sudbury and the Wahnapitae River (already covered by the third report) to Sault Ste Marie and northward about 90 miles. It contains several rivers of considerable size, with the high heads which usually characterize the Laurentian rivers; consequently, many valuable powers exist, and as this is the more thickly settled of the two districts, there is a probability that many of the more promising water powers not already utilized will be taken up in the near future.

The second drainage area is that which extends north and westerly from the north shore of Lake Superior and from Sault Ste Marie westward to the International Boundary. Owing to the comparative proximity of the crest of the height of land to the north shore of Lake Superior throughout the greater part of its length, many of the rivers draining this watershed are short and turbulent, with high heads uniformly characteristic; falls of from fifty to one hundred and twenty-five feet being common.

The two exceptions to this are the Nepigon and Kaministiquia rivers, both of which have large drainage areas, and which possess splendid central lake storages into which the upper tributaries flow.

The maps accompanying this report indicate the location of the chief water falls or powers, such as those on the Spanish, Vermilion, Mississauga, St. Mary's, Montreal, Algoma, Michipicoten, Nepigon, Current and Kaministiquia rivers.

PART II.

DEMANDS FOR POWER.

Previous to the preparation of the following estimates, the various towns in the territory were visited by representatives of the Commission, whose canvass included information in connection with power at present used, power likely to be used in the immediate future, and the probable amount of electric power which could be disposed of to the consumer, if supplied at reasonable rates; this information is set forth in Tables I. and II.

There are at present comparatively few towns in the territory in which any extensive present or probable immediate future demand for power exists, but where any considerable demand was found which could not be supplied locally, it was considered advisable to indicate specific water power developments and transmission schemes by which these available markets could be most reasonably served, and detailed estimates thereon will be found worked out elsewhere in this report.

It must be borne in mind, however, that this whole district is mineralized particularly with iron ores, and that enormous tracts of pulp timber are yet untouched. It can therefore be confidently predicted that with improvements in the methods of electric treatment of ore and with advance in value of pulp, these water powers will form a more than ordinarily important factor in the development of this district.

TABLE I.

POWER CONDITIONS.

NORTH SHORE OF LAKE HURON.

Town.	Population.	Average Total Power Used H.P.	Average Hydraulic Power Used Direct. H.P.	Maximum Hydro-Electric Power Developed. H.P.	Steam Power Available for Electric Installation. H.P.	Remarks.
Copper Cliff...	2,000	3,000	....	3,000	....	Power controlled by Canada Copper Co. Plant at Turbine on the Spanish River.
Espanola.....	....	10,000	8,000	2,000	....	Power on Spanish River, Spanish River Pulp and Paper Co.
Victoria Mines	300	550	....	....	500	Available power on Spanish and Vermilion Rivers.
Massey.....	750	120	....	....	100	Available power on Sable River.
Blind River ...	1,200	820	200	100	100	Available power on Blind River.
Thessalon.....	1,350	800	....	....	150	Available power on Mississauga River.
Bruce Mines ..	860	600	....	...	500	Available power on Mississauga River.
S. S. Marie....	8,763	8,000	1,800	3,500	....	Power developed at St. Mary's Rapids.
Steelton.....	....	....	....	....	....	Available power at St. Mary's Rapids.

TABLE II.

POWER CONDITIONS.

NORTH SHORE OF LAKE SUPERIOR.

Town.	Population.	Average Total Power Used. H.P.	Average Hydraulic Power Used Direct. H.P.	Maximum Hydro-Electric Power Developed H.P.	Steam Power Available for Electric Installation. H.P.	Remarks.
Port Arthur...	10,206	4,000	....	950	2,400	Available power in Current, Nepigon and Kaministiquia Rivers. Current River at present developed by municipality.
Fort William..	10,426	6,000	....	1,500	900	Available power on Nepigon and Kaministiquia Rivers.

PART III.

SOURCES OF HYDRO-ELECTRIC POWER.

Of the rivers flowing into Lake Huron along the north shore, the Spanish, Vermilion and Mississauga are the most important as regards size and hydro-electric possibilities, numerous water powers admitting of more or less economical development existing on these rivers. Two plants are at present in operation on the Spanish River, furnishing power for pulp mills and mines.

This district contains valuable timber and mineral areas, factors which will in the near future have an important bearing in determining the economic value of the available water powers.

Rivers of lesser importance in the same district are the Blind, Sable, Serpent, Onaping and Whitefish.

At the head of Lake Huron is the important international power of the Sault Rapids on the St. Mary's River, which takes the total run-off of the Lake Superior basin. This power is partially developed on both sides of the river and forms the basis of operation for the industries established and controlled by the Lake Superior Corporation at Sault Ste Marie.

Along the north shore of Lake Superior, many fine water powers exist, which, in many cases have but little present economic value; exceptions being the Nepigon, Kaministiquia and Current Rivers, the importance of which is due to the fact that they are within transmission distance of the rapidly increasing power markets of Fort William and Port Arthur, and, especially in the case of the Nepigon, are of sufficient extent to use for grinding the pulp output of the Nepigon watershed.

In the following table is given a list of water powers in the territory covered by the report. As a rule, only those powers possessing fairly good natural head have been included in this list, but it should be understood that in many localities, rapids, or series of rapids, could be drowned out, and an artificial head created by means of a dam. In most cases, the question of back-water damage would not be a serious one, so that the heads obtainable would be limited only by the capital investment in connection with the dam construction.

The figures in the second column of this table indicate uniform low-water flow only, and it must be understood that in practically all cases enough local pondage can be obtained above the headworks to provide for a considerably increased peak capacity. It is not generally feasible, however, to obtain in this way storage sufficient to materially augment the natural dry-weather flow over a greater period than that required to take care of the daily variation of load demands, without a large relative expenditure for impounding storage reservoirs.

To this general observation, there are two notable exceptions, namely, Lake Nepigon, with 1,500 square miles of area, and Dog and Shebandowan Lakes, with 100 square miles of area, serving to create natural storages, which, in the case of Dog Lake, can be enormously increased in value by the expenditure of a small sum for construction of a dam at the outlet of the lake, which will raise the lake level ten to fifteen feet during high-water and hold the same for use when required at low-water periods.

TABLE III.

Water powers in the districts of Algoma and Thunder Bay on rivers tributary to Lake Huron and Lake Superior.

Water-power.	Head Feet.	Estimated Low Water Flow C.F.S.	Minimum 24 hr Power. H.P.	Present Installation. H.P.	Remarks.
SPANISH RIVER:					
Espanola	62	1,800	10,145	10,000	Spanish River Pulp and Paper Co.
Nairn Falls	28	1,027	2,620		
High Falls	85	1,027	7,936	5,400	Canada Copper Co.
Norway Falls and Rapids	40	935	3,400	....	Lot 9, Con. 1, Hyman.
Township, No. 108	14	935	1,190	....	Above Agnes River.
Township, No. 108	32	835	2,429	....	Below " "
Metagama (rapids)	27	400	980		
" "	16	400	580		
Biscotasing "	26	266	630		
VERMILION RIVER:					
Wabageshik Rapid	15	720	980		
" Chute	42	720	2,750		
Soo Line Crossing	15	700	955		
Island Rapids	11	667	667		
Cascade	19	667	1,150		
Big Stoby Falls	35	640	2,040	1,350	Ver. River Power Co.
C.P.R. Crossing	11	500	500		
Larchwood	9	500	410		
Onwatin Lake	18	193	313		

TABLE III.—Water-powers in the districts of Algoma and Thunder Bay on rivers tributary to Lake Huron and Lake Superior.—Continued.

Water-power.	Head Feet.	Estimated Low Water Flow C.F.S.	Minimum 24 hr. Power. H.P.	Present Installation. H.P.	Remarks
ONAPING RIVER:					
High Falls	127	300	3,460		
Fall	15	300	410		
Fall and Rapids	22	240	480		
Rapids	17	180	278		
Onaping Chute (outlet)	11	147	147		
WHITE-FISH RIVER:					
White-fish Falls	47	117	500	....	At mouth of River.
Charleton "	58	85	450		
Long Lake	16	80	116	....	Combined with 9 ft. fall.
SABLE RIVER:					
Bridge Rapids	8	230	167		
Spanish Chute	38.5	230	805	....	½ mile from Massey.
Graveyard Chute	54	230	1,130		
Island Rapids	16	230	334		
Crooked "	19	230	397		
Meareau "	36	230	755		
Cameron Falls	45	230	940		
Long Rapids	16	230	334		
Ragged Rapids	24	200	435		
McKee Falls	39	160	567		
High Falls	51	130	603		
SERPENT RIVER:					
McCarthy's Chute	61	154	855		
1st Log-slide	63	140	800		
2nd "	36	140	460		
3rd "	26	140	330		
4th "	19	140	242		
Fall and Rapids below Whiskey Lake	35	40	128		
Rapids at Big Bear Lake	32	40	116		
BLIND RIVER:					
Blind River	12	96	105	80	Canada Saw Mill Co.
Cataract Falls	23	87	182		
White Falls	55	87	435	....	7¼ miles from Blind River.
High Falls	31	87	245		
Chiblow Lake (outlet)	45	87	356		
MISSISSAUGA RIVER:					
1st Fall	20	1,050	1,910		
2nd Fall	21	1,050	2,000		
‡Slate Falls	32	1,050	3,045	....	Lot No. 12, Con. 6, Gladstone.
4th Fall	18	850	1,390		
5th Fall	31	850	2,400		
Squaw Chute	17.5	850	1,350		
Aubrey Falls and Rapids	117	750	7,980		
Fall	24	420	915		
Head of Lake Minneesagua Fall	13	360	425		
" "	21	180	342		
	38	160	555		
WHITE RIVER: (E. Branch Mississauga).					
Bells Falls	17	210	327		
White Falls	16	100	145		
ST. MARY RIVER:					
Soo Rapids	18	60,000	98,200	6,500	Lake Superior Power Company.

TABLE III.---Water-powers in the districts of Algoma and Thunder Bay on rivers tributary to Lake Huron and Lake Superior.---Continued.

Water-power.	Head Feet.	Estimated Low Water Flow C.F.S.	Minimum 24 hr. Power. H.P.	Present Installation. H.P.	Remarks.
GOULAIS RIVER :					
Lower Fall	61	200	1,109		
Upper Fall	52	125	591		
CHIPPEWA RIVER :					
Fall at mouth	61	85	470		
BATCHEWANA RIVER :					
Fall at mouth	34	110	340		
2nd Falls	35	110	350		Artificial head.
MONTREAL RIVER : (Algoma)					
Fall at mouth	165	340	5,100		
Upper Fall	170	340	5,250	....	Algoma Central crossing.
AGAWA RIVER :					
Fall at mouth	90	175	1,430	....	Including backing up on rapids 10 ft.
MICHIPICOTEN RIVER :					
Michipicoten Falls	128	650	7,564	2,100	Algoma Power Co.
Cat Portage Falls	33	356	1,068		
Pigeon Falls	18	356	585		
Stony Portage Falls	91	234	1,940		
SHEQUAMKA RIVER :					
First Fall	27	292	715		
Second Fall	22	292	585		First and second Fall would be combined by means of a dam at first fall.
Third Fall	32	240	697		
MAGPIE RIVER :					
1st Fall, 2nd Fall, 3rd Fall	113	256	2,630	....	At mouth of river.
4th Fall	77	256	1,790		
5th Fall	63	256	1,470	....	4 miles from Helen Mine.
DOG RIVER :					
Denison Falls	140	125	1,590		
WHITE RIVER :					
1st Fall	50	500	2,280	...	6 miles from L. Superior.
2nd "	40	500	1,820	....	6¼ miles from L. Superior.
3rd "	20	500	910	....	6¾ miles from L. Superior.
4th "	35	500	1,590	....	11¼ miles from L. Superior.
5th "	20	450	820	....	11¾ miles from L. Superior.
6th "	145	450	5 950	....	12¼ miles from L. Superior.
7th "	50	450	2,046	....	13¾ miles from L. Superior.
8th "	50	300	1,360	....	32 miles from L Superior.
9th "	20	300	545	....	27 miles below Montizambert.
10th "	33	250	750	....	25 miles below Montizambert.
11th "	20	225	410	....	15 miles below Montizambert.
PIC RIVER :					
Lake Superior Portage	51	140	650	....	60 miles above Lake Superior.
White Otter Falls	42	130	495		
Sand Hill Portage	115	130	1,360		

TABLE III.---Water-powers in the districts of Algoma and Thunder Bay on rivers tributary to Lake Huron and Lake Superior.—Concluded.

Water-power.	Head	Estimated Low Water Flow C.F.S.	Minimum 24 hr. Power. H.H.	Present Installation. H P.	Remarks.
STEEL RIVER :					
Simpson's Stretch	71	150	970	....	7 miles from Jackfish.
BLACK RIVER :					
Falls at mouth	106	75	725	....	7 miles east of Schreiber.
NEPIGON RIVER :					
‡Cameron Rapids	39	5,500	19,500	....	14 miles from Nepigon Station.
Split Rock	15	5,500	7,500		
Island Portage	9.5	5,500	4,750		
Pine Portage Rapids					
White Chute	12	5,500	6,000		
Victoria Rapids	10	5,500	5,000		
Camp Miner Rapids	7	5,500	3,500		
Virgin Falls	25	5,500	12,500	....	30 miles from Nepigon Station.
Flat Rock	38	5,500	19,000		
NEPIGON TRIBUTARIES :					
STURGEON RIVER					
No-ga-mi-non	42	250	955	....	Adjacent to iron deposits
Beaver Falls	28	250	635	....	
RED PAINT RIVER :	..	125	....	....	No valuable water power.
OMBABIKA RIVER :	..	120	....	....	Good storage but no valuable power.
MUD RIVER :					
WABINOSH :	..	....	....	....	Not explored.
GULL RIVER :					
BLACK STURGEON RIVER :	..	150	..	....	No valuable water power.
WOLF RIVER :					
First Fall	30	100	270	....	
Second Fall	42	100	380	....	
CURRENT RIVER :					
Falls at mouth	86	*130	1,020	1,100	Port Arthur Municipal Plant.
Cascades	100	*100	910		
KAMINISTIQUIA RIVER :					
‡Mt. McKay and Kakabeka Falls Ry	25	830	1,887	....	Lot 2, Block A, Paipoonge.
Kakabeka Falls and Ecarte Rapids	180	800	13,100	10,000	Kaministiquia Power Co.
Rapids	10	800	728		
Rapids	33	450	1,350		
‡Dog Falls	347	450	14,200	....	25 miles from Port Arthur.
PIGEON RIVER :					
High Falls	110	125	1,250	....	At mouth of River.
Cascades	100	60	545		
ARROW RIVER :					
High Falls	37	60	202	....	At mouth of River.
KAWA-KASHKAGAMA RIVER :					
Upper Falls	14	100	127	....	North of height of land, (tributary to Kenogami.)
Howard Falls	21	100	190	....	

‡Proposed development.
* Estimated flow dependent upon adequate storage facilities (Fannings' report.)

PART IV.

GENERATION OF POWER.

In the district covered by this Report, there are comparatively few power developments in existence at the present time. Several of these, however, are of considerable magnitude. In the field of local distribution are included the Spanish River Pulp and Paper Co., Canada Saw Mill Co., Lake Superior Power Co. and the Port Arthur Municipal Plant.

The plant of the Spanish River Pulp & Paper Co. is located at Espanola on the Spanish River. The total development is for 15,000 H.P., of which about 10,000 H. P. is being used at the present time, 8,000 H.P. being taken by direct connected pulp grinders and the remainder on lighting, motor and other loads.

The Canada Saw Mill Co. utilizes a small power at the mouth of the Blind River. The total output is required for the lighting load of the Company's mills and the Town of Blind River.

At Sault Ste Marie, the plant of the Lake Superior Power Co. has a turbine capacity of about 6,500 H.P. Of this 3,800 H.P. is electrical and the remainder is consumed by direct-connected pulp grinders and other pulp-mill machinery.

The Port Arthur Municipal Plant takes its water supply from the Current River. The maximum load on the plant is in the neighborhood of 800 H.P., which under present conditions is excessive. Steps are being taken to improve the storage facilities of the upper river in order to provide for 1,000 H.P. additional maximum capacity.

Of the Companies transmitting at high potential, the Canada Copper Co. and the Kaministiquia Power Co. are the only ones in operation at present. The power station of the Canada Copper Co. is located at Turbine on the Spanish River, and energy is transmitted twenty-two miles to the Company's plant at Copper Cliff over a duplicate transmission line, at 34,000 volts, three-phase 25-cycles. The present capacity of the plant is 5,400 H.P. and two additional units of 2,700 H.P. each are to be installed this year, making 10,800 H.P. in all.

The Kaministiquia Power Co. has an extensive plant at Kakabeka Falls on the Kaministiquia River, with a partial installation of 10,000 H.P., which, it is stated, is shortly to be doubled. The plant is in operation at present and transmits power over a 25-mile double transmission line to Fort William at 25,000 volts, 3-phase, 60-cycles.

At Big Stoby Falls on the Vermilion River is the plant of the Vermilion River Power Co., which has an installation of 1,350 H.P. capacity. This plant is within transmission distance of Victoria Mines, Copper Cliff and Sudbury, but is not in operation at present.

The Algoma Power Co. has a plant under construction at Michipicoten Falls, on the Michipicoten River. This plant is to have an initial capacity of 2,100 H.P., the prospective market being the neighboring mines, of which there are a considerable number, the estimated demand being about 1,500 H.P.

The Mount McKay & Kakabeka Falls Power Co. propose to develop a 25-foot head on the Kaministiquia River in the Township of Paipoonge, about seven miles from Fort William, where it is the intention to drown out a series of rapids by means of a dam. Under dry weather conditions, the flow would be sufficient to generate 1,500 H.P., but with storage and regulation, such as will be necessary in connection with plants on the upper river, this output could be doubled. The capital investment necessary in this case will be very heavy, owing to the extensive dam construction. It is understood that this power is required chiefly for the operation of a suburban electric railway.

A considerable number of towns in this district have sufficient water power latent in their immediate neighborhood to supply their probable needs when the demand arises. Of these the following may be mentioned: Schreiber, 725 H.P. on the Black River, 7-mile transmission; Jackfish, 970 H.P. on the Steel River, 7-mile transmission; White River, 200 H.P. on the White River, adjacent to town; Blind River, 435 H.P. on the Blind River, 7 1-4-mile transmission; Massey, 805 H.P. on the Sable River, 1-2-mile transmission.

As a result of investigation as to present and probable immediate future demands for power in this district, three tentative schemes of development have been considered, by which these demands could be most reasonably met. They are, (1) Dog Lake, at the head waters

of the Kaministiquia, 347 feet natural head; (2) Cameron Rapids on the Nepigon, 39 feet natural head; (3) Slate Falls on the Mississauga 31 feet natural head.

(1) Dog Lake Development: This power is situated about 25 miles northwest of the towns of Port Arthur and Fort William. An effective head of 310 feet can be obtained by utilizing the difference in level between Big Dog and Little Dog Lake. The distinguishing feature of the development would be the construction of about 3,500 feet of head-water tunnel. The value of this power is due to the high head and the exceptionally good storage facilities of Dog Lake, which has an area of 53 square miles.

(2) Cameron Rapids Development: This power is situated on the Nepigon River, about 14 miles north of Nepigon Station. The very considerable economic importance of this power is due to the fact, already mentioned, that it is within transmission distance of Port Arthur and Fort William, and that it is available for the development of the extensive pulpwood areas of the Nepigon watershed. In addition to this, the remarkably favorable topographical conditions in the neighborhood of the power-site, and the magnificent storage facilities offered by Lake Nepigon, with its 1,500 square miles of area, which would obviate all necessity for artificial regulation for some time to come, combine to make this a most attractive proposition from an engineering standpoint.

(3) Slate Falls Development: This power is situated on the Mississauga River about 25 miles from the town of Bruce Mines. A head of 40 feet can be obtained here, and in view of the natural conditions, the scheme of development is simple. No natural storage basins are available in the vicinity, but the dam necessary for the development will provide storage sufficient for any daily peak load within the limit of the temporary overload capacity.

Details as to horse power to be developed, capital costs and annual charges will be found in table IV. and V. following. These estimates are based on information collected by the Commission's engineers and on such other information as was available and known to be authentic. In the half-load estimates, it is assumed that permanent works for full capacity will be constructed at the outset. This includes dam, forebay, foundations, buildings, etc.

TABLE IV.

ESTIMATED CAPITAL COST OF DEVELOPMENTS.

Location of water-power.	Net amount of power to be developed. H.P.		Total capital cost.		Cost per H.P.	
	Full Capacity.	Half Capacity.	Full Capacity.	Half Capacity.	Full Capacity.	Half Capacity.
Dog Lake	13,675	6,840	$832,000	$619,700	$61 00	$91 00
Cameron Rapids	16,350	8,250	815,000	600,000	50 00	73 00
Slate Falls	3,686	1,843	357,600	260,000	97 00	141 00

The capital cost in each case includes step-up transformer stations, one reserve unit in excess of each of the above mentioned capacities and a spare transformer in each station.

TABLE V.

ESTIMATED ANNUAL CHARGES ON GENERATING PLANTS.

Items.	Dog Lake.		Cameron Rapids.		Slate Falls.	
	Full Capacity.	Half Capacity.	Full Capacity.	Half Capacity.	Full Capacity.	Half Capacity.
Wages administration, step-up transformer losses	$13,760	$11,296	$16,375	$14,390	$6,000	$6,000
Maintenance and repairs	16,427	10,632	17,327	11,478	6,634	3,868
Replacement fund	15,927	10,132	16,727	10,978	6,334	3,669
Interest at 4 per cent	33,278	24,787	32,561	24,008	14,303	10,400
Total annual charges.	$79,392	$56,847	$82,990	$60,854	$33,271	23,937

PART V.

TRANSMISSION OF POWER.

In connection with the hydraulic developments dealt with in the previous section, three specific transmission schemes have been assumed as best meeting present and probable future power require-

ments. They are as follows: (1) A line from Dog Lake to Port Arthur, Fort William and vicinity; (2) a line from Cameron Rapids on the Nepigon to Port Arthur, Fort William and vicinity; (3) a line from Slate Falls on the Mississauga, to Thessalon and Bruce Mines.

Detailed estimates on these schemes will be found in table VI. In all cases, the use of a high-class wood pole has been assumed, with telephone wires on the same poles. The transmission table (VI.) shows the capital cost and annual charges on the transmission lines from the step-up transformer station at the various points of development to the step-down stations at points of local distribution. The annual charges include depreciation and repairs, interest and cost of patrol.

The table of transformation details gives particulars concerning the proposed transformer stations. In all cases, the stations are assumed as being built for full capacity at the outset, with equipment to be installed as required. The transformation charges provide for municipal taxes on building, insurance, depreciation, engineering and contingencies, and interest during construction.

The summation sheet contains the charges for transmission, transformation and administration chargeable to each municipality, to which is added in each case the cost of power at the generating station The final column is for 24-hour power at low-tension bus-bars of the various municipal substations.

In Table IX. is shown in condensed form the total investment and the annual charges for transmission and stepdown transformation: also the cost per annum per horse-power ready for distribution from the low-tension bus-bars in the various towns.

TABLE VI.

TRANSMISSION DETAILS.

SHOWING CAPITAL COST AND ANNUAL CHARGES.

Item.	Dog Lake to Port Arthur 33,000 V. 60 Cycles.		Cameron Rapids to Port Arthur 60,000 V. 60 Cycles.		Slate Falls to Bruce Mines 40,000 V. 60 Cycles.		Slate Falls to Thessalon 40,000 V. 60 Cycles.	
	Full Capacity.	Half Capacity.	Full Capacity.	Half Capacity.	Full Capacity.	Half Capacity.	Full Capacity.	Half Capacity.
Miles	25	25	75	75	26	26	16	16
Area of Conductors—M.c.m.	300	150	190	95	83	83	83	83
Capital Cost per Mile :—								
Equipment	5,603.00	2,831.00	4,524.00	2,292.00	4,003.00	3,919.70	91.00	174.30
Right of way protection	100.00	100.00	100.00	100.00	195.70	191.70	4.30	8.30
Engineering and contingencies	1,140.00	586.00	925.00	478.00	839.00	821.50	19.00	36.50
Total	6,843.00	3,517.00	5,549.00	2,870.00	5,037.70	4,932.90	114.30	219.10
Total capital cost	$171,075.00	$87,925.00	$416,175.00	$215,250.00	$65,503.20	$63,823.70	$1,828.80	$3,509.30
Capital Charges per Mile :—								
Equipment	337.75	171.25	305.40	155.10	276.76	271.08	6.30	11.98
Right of way protection	5.50	5.50	5.50	5.50	10.75	10.50	.25	.50
Engineering and contingencies	68.65	35.35	62.20	32.10	57.48	56.30	1.31	2.49
Total	411.90	212.10	373.10	192.70	344.99	337.88	7.86	14.97
Total capital charges	$10,297.00	$5,303.00	$27,981.00	$14,452.00	$4,477.24	$4,363.48	125.76	239.52
Patrol	900.00	900.00	2,250.00	2,250.00	1,012.00	986.70	28.00	53.30
Total annual charges	$11,197.00	$6,203.00	$30,231.00	$16,702.00	$5,489.00	$5,350.00	$154.00	$293.00
Loss of power, H.P.	915.00	460.00	1,900.00	945.00	167.00	38.00	4.00	2.00

TABLE VII.

TRANSFORMATION DETAILS.

SHOWING CAPITAL COSTS AND ANNUAL CHARGES.

Item.	Port Arthur (Dog Lake Scheme.)		Port Arthur (Cameron Rapids.)		Bruce Mines (Slate Falls.)		Thessalon (Slate Falls.)	
	Full Capacity.	Half Capacity.	Full Capacity.	Half Capacity.	Full Capacity.	Half Capacity.	Full Capacity.	Half Capacity.
Capacity, H.P.	12,382	6,187	14,025	7 010	3 300	1,650	150	150
Capital Cost :—								Same station used as for full generation capacity.
Building and lot	16,000.00	16,000.00	21,000.00	21 000.00	7,000 00	7,000.00	3,000.00	
Equipment	90,780.00	53,385.00	95 055.00	62 000.00	43,955.00	28,015.00	11,435.00	
Engineering and contingencies	10,578.00	6,839.00	11,605.00	8,300.00	5.196.00	3,502.00	1,444.00	
Interest during construction	2,327.00	1,504.00	2,553.00	1 826.00	1,143.00	770.00	318.00	
Total	$118,685.00	$76,728.00	$130 213.00	$93,126.00	$58,294.00	$39,287.00	$16,197.00	
Annual Charges :—								
Maintenance and depreciation	6,236.00	3,012.00	6,483 00	4,254.00	3,090.73	1,544.09	749.88	
Interest, 4 per cent	4,747.00	3,071.00	5,209.00	3,725.00	2,331.76	1 571.48	647.88	
Operation	4,000.00	4,000.00	5,000.00	4,500.00	4,400.00	4,000.00	1,000.00	
Total	$14,983.00	$10,083.00	$16,692.00	$12,479.00	$9,882.00	$7,476 00	$2,398.00	$2,398.00

TABLE VIII.

SUMMATION SHEET.

SHOWING ANNUAL COST OF POWER ON 24 HOUR BASIS AT SUB-STATION LOW TENSION BUS-BARS.

Item.	Port Arthur (Dog Lake.)		Port Arthur (Cameron Rapids.)		Bruce Mines. (Slate Falls.)		Thessalon (Slate Falls.)	
	Full Capacity.	Half Capacity.	Full Capacity.	Half Capacity.	Full Capacity.	Half Capacity.	Full Capacity.	Half Capacity.
Population :—	10,206	....	10,206	....	860	....	1,350	....
Annual Charges :—								
Generation, including step-up transformation	79,392	56,847	82,990	60,854	31,825	22,109	1,446	1,828
Transmission	11,197	6,203	30,231	16,702	5,489	5,350	154	293
Step-down transformation	14,983	10,083	16,692	12,479	9,823	7,476	2,398	2,398
Administration	6,850	4,820	6,656	6,097	1,434	1,375	66	125
Total	$112,422	$77,953	$136,569	$96,132	$48,571	$36,310	$4,064	$4,644
Total H.P. developed	14,100	7,050	16,850	8,500	3,620	1,787	165	163
Net H.P. delivered, all losses deducted	12,382	6,187	14,025	7,010	3,300	1,650	150	150
Total annual cost of 24-hour power at low tension bus-bars, step-down transformer station	$9.10	$12.60	$9.75	$13.70	$14.72	$22.00	$27.10	$30.92

TABLE IX.

TRANSMISSION INVESTMENTS.

Item.	Port Arthur (Dog Lake.)		Port Arthur (Cameron Rapids.)		Bruce Mines (Slate Falls.)		Thessalon (Slate Falls)	
	Full Capacity.	Half Capacity.	Full Capacity.	Half Capacity.	Full Capacity.	Half Capacity.	Full Capacity.	Half Capacity.
Total H.P. distributed	12,382	6,187	14,025	7,010	3,300	1,650	150	150
Total Investment, including step-down transformer stations	289,760	164,653	451,558	308,376	123,977	103,111	18,026	19,706
Investment per H.P. delivered	$23.40	$26.60	$32.20	$44.00	$37.55	$62.50	$121.00	$131.20
Total annual repairs, depreciation, operation and administration	14,600	9,700	28,861	16,846	10,353	8,702	1,831	1,903
Interest, 4 per cent	11,590	6,586	18,062	12,335	4,959	4,124	721	788
Total	$26,190	$16,286	$46,923	$29,181	$15,312	$12,826	$2,552	$2,691
Cost of 24-hour power per annum, including line and transformer losses	$9.10	$12.60	$9.75	$13.70	$14.72	$22.00	$27.10	$30.92

INDIVIDUAL TRANSMISSION.

The various sub-stations have been estimated on the basis of transformation down to 2,200 volts, but the cost of distribution of power at this voltage will be dealt with in Part VI. Many instances arise, however, in which it is desired to supply a single large consumer or a small municipality at some distance from a sub-station. When this is the case the following table may be made use of. The total cost of power to such a consumer is ascertained by adding the rate per H.P. from this table to the cost of power at the nearest municipal sub-station. The charges for such a branch transmission do not include any allowance of right of way or telephone, it being assumed that the highways would be available for such low voltage lines.

TABLE X.

SHOWING COST OF DISTRIBUTION FROM MUNICIPAL SUB-STATION TO AN INDIVIDUAL CONSUMER, NOT COVERED BY LOCAL DISTRIBUTION.

Distance in Miles from Municipal Sub-station.	Cost per Horse-Power per Annum for the Delivery of Various Amounts of Power.							
	50 H.P.	75 H.P.	100 H.P.	150 H.P.	200 H.P.	250 H.P.	300 H.P.	
2	$5.58	$4.20	$3.53	$2.92	$2.74	$2.60	$2.51	2,200 Volts
3	6.89	5 20	4.41	3.60	3.25	3.10	3.03	
4	7.92	6.18	5.20	4.27	3.93	3.72	3.86	
5	8.87	7.18	5.98	4.96	4.55	4.32	4.17	
6	10.20	8.24	6.77	5.38	5.13	4.60	4.43	
8	14.10	10.14	8.40	6.97	6 24	5 79	5.58	11,000 Volts
10	16.12	12.13	9.54	8.31	7.68	6.96	6.17	
12	18.76	14.03	11.12	10.12	8.42	7.96	7.22	16,500 Volts
15	22.74	17.08	13.48	10.89	9.35	8.84	8.32	

PART VI.

DISTRIBUTION OF POWER.

The cost of distribution from the municipal sub-stations to the consumers' premises varies widely with different conditions and de-

pends upon the distances involved, the magnitude of the demands of individual consumers and the grouping of these consumers.

This cost of distribution will not necessarily, however, give the increase of cost to the consumer above that paid for the power by the municipality unless a method of charging be chosen which will take into account the difference between the sum of the consumers' maximum demands and the maximum demand on the station. If the charging rate for power were one composed of a flat rate based on maximum demand plus a rate per k.w.-hour or H.P.-hour actually registered by meter, then it would be approximately correct to say that the combined rate per H.P. to the consumer should be the same as the cost of power at the sub-station plus the cost per H.P. of the distribution service. Besides this the ordinary municipality has such various means of modifying the rates for power, such as limited-hour contracts with motor users, contract with summer users of electric power, etc., that fair rates could only be established after a careful study of the actual conditions after operations were begun. Under average conditions in a town demanding 1,000 H.P. or over, it could reasonably be expected that 10-hour power could be sold at the same or even a lower rate, if based on maximum demand, than that charged the municipality for 24-hour power at the sub-stations. In other words, the municipality might expect to profit sufficiently from overlapping peaks, 24-hour power for lighting, pumping, general motor users, etc, etc., to pay the cost of its distribution.

PART VII.

MOTOR INSTALLATIONS.

To complete the information regarding the cost of electric power to the consumer, the following table is given, showing the cost of induction motor service per H.P. per year.

TABLE XI.

CAPITAL COST AND ANNUAL CHARGES ON MOTOR INSTALLATIONS, POLYPHASE, 60-CYCLE INDUCTION MOTORS.

Capacity. H.P.	Capital Cost per H.P. Installed.	ANNUAL CHARGES.			
		Interest 5%	Depreciation and Repairs, 6%	Oil, Care and Operation.	Total per H.P. per Annum.
5	$39.00	$1.95	$2.34	$4.00	$8.29
10	36.00	1.80	2.16	3.00	6.96
15	30.00	1.50	1.80	2.50	5.80
25	25.00	1.25	1.50	2.00	4.75
35	22.00	1.10	1.32	1.75	4.17
50	20.00	1.00	1.20	1.50	3.70
75	19.00	.95	1.14	1.25	3.34
100	17.00	.85	1.02	1.00	2.87
150	15.00	.75	.90	.80	2.45
200	14 00	.70	.84	.70	2.24

By combining the costs given in this table with the cost of distributed power, as indicated in Part VI., the final or total charge per H.P. per year will be obtained.

PART VIII.

SINKING FUND.

In the above estimates for transmission and transformation, depreciation and replacement have been provided for which would replace the different classes of plant in periods ranging from 15 to 30 years.

The charges would, therefore, amply serve the purpose of any sinking fund which might be considered needful. In the case of the generating plant estimates, however, these charges would not be sufficient for such a purpose in the so-called permanent portions of the development, comprising the dam, head-works, power house, etc.

A forty-year sinking fund to cover these portions of the development amounting, on the average, to about $50 expenditure per H.P. of capacity would require a charge of $0.55 per H.P. to repay this expenditure in 40 years, interest being calculated at 4 per cent.

PART IX.

EXISTING RATES.

In Table XII., following, will be found a statement of the lighting and power rates in a number of municipalities throughout the district:—

TABLE XII.

EXISTING RATES.

Municipality.	Street Lighting per Year.	Incandescent Lighting.				Power.	Source of Power.	Control
		Commercial.		Residential.				
		Meter-rate per K. W. Hour in cents.	Flat rate per 16 C.P. Lamp per Year.	Meter-rate per K.W. Hour in cents.	Flat rate per 16 C.P. Lamp per Year.	Flat rate per H.P. per Year.		
Fort William	$40 all night.	7.5	$5.40	7.5	$3.75	$25.00	Water and Steam.	Private and Municipal.
Port Arthur	indefinite. all night.	6—10 15% off.	$4.80—$9.00 15% off.	7—10 10% off.	$2.40—$6.60 10% off.	....	Water.	Municipal.
Copper Cliff	2,000 c. p. indefinite.	....	$2.40—$4.80	....	$2.40—$4.80	....	Water.	Private.
Blind River	32 c.p.—$12 all and every night	....	$3.00—$4.80	....	$3.00—$6.00	....	Water and Steam.	Private.
Thessalon	1,200 c.p. Arc $76 all night.	....	$3.00	....	$3.00	....	Steam.	Municipal.
Bruce Mines	32 c.p.- $12	....	$3.00—$6.00	....	$3.00—$6.00	....	Steam.	Private.
Sault Ste. Marie	1,200 c.p. Arc $70 all night.	5—10	$6.00	5—10	$3.00—$6.00	$50.00	Water.	Private.

PART X.

STEAM POWER.

In order to institute a comparison between the cost of electric power as has just been set forth and the cost of power generated by steam or producer gas, the following tables have been compiled after a careful study of data available in technical journals and also from data collected by the Commission's engineers in various towns within the district under consideration. The capital costs have been compiled from information supplied by various makers of engines and other machinery. The tables represent average working conditions and assume a high-class installation.

TABLE XIII.

STEAM POWER PLANTS.

SHOWING CAPITAL COSTS OF PLANTS INSTALLED AND ANNUAL COSTS OF POWER PER BRAKE HORSE-POWER.

Size of Plant, H.P.	Capital Cost of Plant per H.P. installed.			Annual Cost of 10-hour Power per B.H.P.	Annual Cost of 24-hour Power per B.H.P.
	Engines, Boilers, etc., installed.	Buildings.	Total.		
	CLASS I.—Engines: Simple, slide valve, non-condensing. Boilers: Return tubular.				
10	$66.00	$40.00	$106.00	$91.16	$180.76
20	56.00	37.00	93.00	76.31	151.48
30	48.70	35.00	83.70	66.46	131.68
40	44.75	33.50	78.25	59.49	117.74
50	43.00	31.00	74.00	53.95	106.46
	CLASS II.—Engines: Simple, Corliss, non-condensing. Boilers: Return tubular.				
30	70.70	35.00	105.70	61.14	117.70
40	62.85	33.50	96.35	55.50	107.10
50	59.00	31.00	90.00	50.70	97.73
60	56.00	30.00	86.70	47.42	91.34
80	50.00	27.50	77.50	43.86	85.41
100	44.60	25.00	69.60	40.55	79.19
	CLASS III.—Engines: Compound, Corliss, condensing. Boilers: Return tubular with reserve capacity.				
100	63.40	28.00	91.40	33.18	60.05
150	53.70	24.00	77.70	29.83	54.63
200	50.10	20.00	70.10	28.14	51.72
300	45.90	18.00	63.90	26.27	48.83
400	43.55	16.00	59.55	24.84	46.12
500	41.25	14.00	55.25	23.73	44.21
750	40.50	13.00	53.50	23.56	44.02
1000	39.00	12.00	51.00	23.26	43.71
	CLASS IV.—Engines: Compound, Corliss, condensing. Boilers: Water-tube, with reserve capacity.				
300	55.20	18.00	73.20	25.77	46.32
400	51.50	16.00	67.50	24.18	43.61
500	49.40	14.00	63.40	23.19	42.03
750	46.80	13.00	59.70	22.88	41.56
1000	44.30	12.00	56.80	22.47	41.11

NOTE.—Annual costs include interest at 5 per cent., depreciation and repairs on plant, oil and waste, labor and fuel (coal at $4.00 per ton). Brake horse-power is the mechanical power at engine shaft.

It will be noted that for a consumer requiring a large installation operating for ten hours only, there appears to be little advantage to be derived from the use of transmitted electric power, provided the power is not to be distributed throughout a consumer's buildings by a complicated system of shafting, belts, etc. But in the majority of cases this condition obtains, and herein lies one of the specific advantages of electric power. Motors can be installed on each floor of the factory, or even on each machine, with but little loss in efficiency, and only such motors as are required to drive the machinery in use from time to time need be operated. In many cases due to this fact the total electric power consumption of a large factory would be reduced from 25 per cent. to 50 per cent. below that which is required under steam operation, working from a central station.

Again, where electric power is available throughout the 24 hours many industries will work night and day, thereby effecting a great economy, as is evidenced by a comparison of the cost of 24-hour steam or producer gas power with 24-hour electric power.

Perhaps the most striking advantage to be derived from the use of electric power as compared with other power, is that the small consumer can obtain power at a rate which should not be appreciably greater than that made to the large consumer, although the present practice in selling electric power is to discriminate against the small consumer for the reason that electric power prices made by private companies are not based on cost of service, but are merely made with a view to displacing steam.

PART XI.

PRODUCER GAS POWER.

TABLE XIV.

SHOWING CAPITAL COSTS OF PRODUCER GAS PLANTS INSTALLED, AND ANNUAL COSTS OF POWER PER BRAKE HORSE-POWER.

Size of Plant, H.P.	Capital Cost of Plant per H.P. Installed.			Annual Cost of 10-hour Power per B.H.P.	Annual Cost of 24-hour Power per B.H.P.
	Machinery, etc.	Buildings.	Total		
10	$137.00	$40.00	$177.00	$53.48	$90.02
20	110.00	36.00	146.00	44.47	75.22
30	93.00	33.00	126.00	38.73	65.99
40	84.50	29.00	113.50	35.05	59.85
50	80.00	26.00	106.00	32.27	55.22
60	79.00	24.00	103.00	30.49	52.03
80	78.20	22.00	100.20	28.70	48.95
100	77.50	20.00	97.50	27.05	45.40
150	76.00	19.00	95.00	25.87	43.17
200	74.00	17.00	91.00	24.95	41.78
300	73.00	16.00	89.00	24.24	40.40
400	71.50	14.00	85.50	23.41	39.03
500	70.00	12.00	82.00	22.54	37.54
750	67.50	10.00	77.50	21.55	35.99
1000	65.00	8.00	73.00	20.46	34.66

NOTE.—Annual costs include: interest at 5 per cent., depreciation and repairs on plant, oil and waste, labor and fuel (Bituminous coal at $4.00 and Anthracite coal at $5.00 per ton).

A reference to Table XIII. will show that the cost of power developed by producer-gas plants and gas engines is less than that produced by steam plants of the same capacity. It may be said, however, that up to the present no very large installations of suction producers have been made, 250 to 300 horse-power being about the maximum. But this has been provided for in the table by assuming that the larger plants will be made up of several units, each unit being not greater than 350 H.P. capacity. While operation of producer-gas plants has not been going on many years, and complete knowledge on the subject is not available, with the information at hand it is believed that in many situations this form of power producer will be found more economical than a steam plant, and therefore a closer competitor of hydro-electric power. It must be remembered that the same objections hold against the producer-gas plant as those which

have been mentioned in reference to steam plants, namely, that 24-hour power costs proportionately more than 10-hour power; that the small consumer does not have the great advantage obtainable by the use of electric power; and also that a central installation in a factory is all that is possible if electric motors are required in various parts of the factory, and the only prime mover available is steam or gas. This will make the cost of electric factory operation very expensive, and considerably higher than the power costs shown in Table VIII. Speaking generally, however, it may be said that producer-gas plants have a bright future and as the design and construction is perfected undoubtedly the capital cost will be reduced and the cost of power lessened.

TABLE XV.

SHOWING THE EFFECT ON THE COST OF POWER OF A VARIATION IN THE PRICE OF COAL OF ONE-HALF DOLLAR PER TON.

Size of Plant. H.P.	Suction Producer Gas.		Steam.		
	10-Hour.	24-Hour.	10-Hour.		24-Hour.
10	$1.15	$2.53	Simple	$6.14	$13.47
20	1.13	2.46	Slide Valve	5.25	11.56
30	1.10	2.40	Engine.	4.71	10.35
40	1.07	2.33		3.56	7.84
50	1.04	2.29	Simple Automatic	3.37	7.41
60	1.01	2.24	Non-	3.26	7.16
80	.98	2.18	condensing.	3.15	6.97
100	.96	2.12		3.12	6.87
150	.94	2.07		1.75	3.85
200	.92	2.02	Compound	1.69	3.71
300	.90	1.98	Condensing.	1.62	3.60
400	.88	1.94		1.56	3.44
500	.86	1.89	Compound Con-	1.39	3.05
750	.82	1.81	densing; Water-	1.39	3.05
1,000	.76	1.72	tube Boilers.	1.39	3.05

APPENDIX

TO

FIFTH REPORT

Rainy River District.

ENGINEER'S REPORT

ON

THE WATER POWERS AND ON THE GENERATION OF ELECTRIC POWER THEREFROM.

HONOURABLE ADAM BECK,

CHAIRMAN OF THE HYDRO-ELECTRIC POWER COMMISSION.

DEAR SIR:—

Herewith find my report on the Rainy River District, being that portion of Ontario identical with the judicial district of Rainy River.

The report deals with the present consumption of and demand for power, and the sources of power developed and undeveloped. There are no long distance transmission systems in this district, and there does not appear at the present time to be any demand for such, unless the operating of certain mines might in the future require the transmission of power.

Yours respectfully,

CECIL B. SMITH,

Chief Engineer.

TORONTO, CANADA,
APRIL 15TH, 1907.

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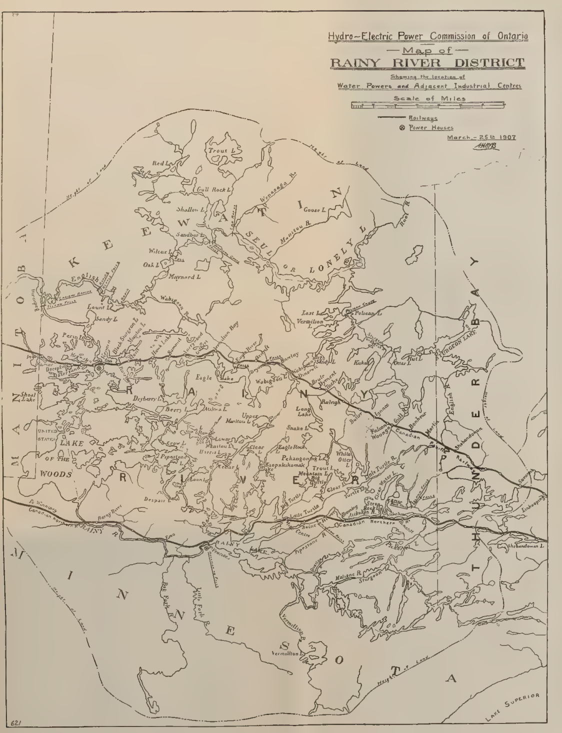
Hydro-Electric Power Commission of Ontario
—Map of—
RAINY RIVER DISTRICT
Showing the location of
Water Powers and Adjacent Industrial Centres
Scale of Miles
Railways
Power Houses
March, - 25th 1907
KEEWATIN
RAINY RIVER
THUNDER BAY
MANITOBA
MINNESOTA
LAKE OF THE WOODS
UNITED STATES
SEUL OR LONELY L
Trout L
Red L
Gull Rock L
Shallow L
Goose L
Wenasaga R.
Manitou R
Sandbar L
Wilcox L
Oak L
Maynard L
English R
Lount L
Sandy L
Wabigoon
Vermilion Bay
Eagle Lake
Dryden
Barclay
Wabigoon L
Dinorwic
Lost L
Vermilion L
Pelican L
Otter L
Kuke
Sturgeon Lake
Shoal Lake
Dryberry L
Berry L
Upper Manitou L
Lower Manitou L
Long Lake
Raleigh
Ignace
Bonheur
Canadian
Snake L
Eagle Rock
Clear L
Pekagoning L
White Otter L
Trout L
Mountain L
Big Turtle L
Little Turtle R
Crow L
Pipestone L
Despair L
Rainy River
RAINY R
Emo
Canadian Northern Ry.
RAINY LAKE
Pipestone R
Seine R
Atikokan R
Clear Water L
Savanne
Shebandowan L
Sturgeon R
Vermillion R
Vermillion L
Big Fork R
Little Fork
Lake Superior
Height of Land
621

PART I.

GEOGRAPHICAL SUBDIVISIONS.

This report will deal with the hydro-electric conditions and present requirements of the extreme western portion of the Province, embracing practically the district of Rainy River. This district is probably the most copiously watered of any in the Province, water powers being abundant, and in many cases of considerable magnitude.

As in the case of Algoma and Thunder Bay districts, only the important water powers in the neighborhood of existing or prospective industrial centres have been examined in detail, the more remote power sources being discussed in a general way.

The whole of the district under discussion is embraced by one drainage area, being part of an immense system, the run-off of which reaches tide-water in Hudson's Bay by way of the Winnipeg River, Lake Winnipeg and the Nelson River.

The rivers in this district, as a general rule, are large and full flowing, with comparatively low heads, which disadvantage is in a measure offset by the splendid natural storage facilities offered by Rainy Lake, Lake of the Woods, Lac Seul and numerous other lakes of lesser magnitude plentifully distributed throughout the district.

The map accompanying this report indicates the location of the chief water falls or powers, such as those on the Rainy, Winnipeg, Seine, Wabigoon and English rivers.

PART II.

DEMANDS FOR POWER.

The power market in this district at the present time is confined almost wholly to the town of Kenora, where the population is sufficiently large to create a profitable municipal market, besides which there are several manufacturing establishments, chiefly flour mills, using a considerable quantity of power. Fort Frances, owing to its geographical situation as a border town, and to the hydraulic possibilities of the Koochiching Falls, will doubtless play an important part in the future industrial development of the district. Lumber-

ing is now, and will be for some time to come, an important industry, and as the waste material from the mills furnishes abundant fuel for the generation of steam, none of the smaller towns need be considered as possible users of hydro-electric power.

The mineral areas in this district, though not actively developed at present, may at some future time attain sufficient importance to warrant development of such of the abundant existing water powers as may be convenient.

PART III.

SOURCES OF HYDRO-ELECTRIC POWER.

The most important rivers in this district are the Winnipeg, Rainy, Seine and English rivers.

Seine River:—This river takes its rise in Lac des Milles Lacs, and flows in a generally southwesterly direction to Rainy Lake. Though not possessing any tributaries of importance, its considerable length and good natural storage facilities combine to give it the uniform flow which is common to all the more important rivers in this district, and distinguishes them from most of the rivers of Algoma and Thunder Bay, tributary to the Great Lakes.

The mineral belt through which this river flows may possibly reach a stage of development sufficient to warrant the utilization of several favorable power sites, where economical development is feasible.

Rainy River:—This river rises in Rainy Lake, forms the international boundary between Ontario and Minnesota and discharges into the Lake of the Woods. This is one of the large rivers of Ontario, and permits of steamboat navigation to the foot of Koochiching Falls at the source of the river. This fall is now in process of development.

Winnipeg River:—This river, which is one of the largest in Canada, rises in the Lake of the Woods, and flows in a northwesterly direction to Lake Winnipeg, draining in its course the whole of Rainy River District, large portions of Southern Keewatin, Northern Minnesota and the western extremity of Thunder Bay District, in all about 55,000 square miles. Although the natural heads on this river are not great, the heavy minimum flow makes possible the development

of very large blocks of power. Several developments in various stages of construction exist at the present time, and so far it has been found necessary to use only a fraction of the total discharge of the river.

English River:—This river is also a tributary of the Winnipeg River, the confluence being about fifty miles northwest of Kenora. This river rises in Scotch Lake, south of the main line of the C. P. R., and flows northwesterly for nearly 100 miles to Lac Seul, a lake in the same class as Lake of the Woods and Lake Nepigon, as regards size. After leaving Lac Seul, the river flows in a southwesterly direction for 250 miles to the junction with the Winnipeg River, forming a portion of the boundary between Ontario and the district of Keewatin. Apart from its great length, this river is remarkable, in that it consists mainly of a series of large lakes connected by short rapids and falls. For this reason, its natural storage facilities are unequalled elsewhere in the Province, with the possible exception of the Winnipeg River. The natural resources of the country through which the river flows are comparatively meagre, as the rock formation is not mineralized to any extent, being nearly all Laurentian granite. The timber, as a rule, is sparsely distributed, consisting principally of poplar and small spruce and jack pine, with a small percentage suitable for tie-timber.

In the following table is given a list of water powers in the territory covered by the report. Unless otherwise stated only those powers possessing fairly good natural heads have been included in this list, but it should be understood that in many localities rapids, or series of rapids, could be drowned out and an artificial head created by means of a dam. In most cases the question of back water damage would not be a serious one, so that the heads obtainable would be limited only by the capital investment in connection with the dam estimates thereon will be found worked out elsewhere in this report. construction.

The figures in the second column of this table indicate uniform low water flow, and it is important to note that in this district, in almost every case, the dam construction necessary in connection with any power installation would provide storage sufficient, not only for daily peak load demands, but also to appreciably augment the present low water flow during the dry-weather period. The system of artificial regulation could be extended as required, by constructing dams at the various lake outlets, such as those now constructed at

Kenora, and by so doing the minimum 24-hour flow can be very much increased, in fact, the power capacity of the district can be augmented until probably 40 per cent. of the annual rainfall could be utilized for power purposes.

Water Power.	Head	Estimated Low Water Flow C.F.S.	Min. 24 Hour Power. H.P.	Present Installation.	Remarks.
SEINE RIVER :					
Seine Falls	11	800	800	....	
Island Falls	20	832	1,510	....	Minto Mine adjacent.
Lynx-head Chute	11	880	880	....	
Steep-rock Falls	40	960	2,900	....	
Sturgeon Falls	13	1,120	1,320	....	
RAINY RIVER :					
Koochiching Falls	23	6,700	14,000	....	In process of development. ½ of this available to Ontario.
WINNIPEG RIVER :					
E. Branch Kenora	18	2,500	4,100	....	
W. " "	18	11,000	18,000	....	
Island Falls	45	14,500	59,300	....	Combined artificial head.
WABIGOON RIVER :					
Upper Fall, Dryden	26	240	568	....	
Lower Rapids, "	22	240	480	....	
ENGLISH RIVER :					
Pelican Chute	12	3,200	3,490	....	
Ear Rapids	29	6,100	16,100	....	Combined artificial head.
Manitou Chute	28	7,000	17,800	....	
Fall	15	7,100	9,670	....	
Rapids	6	7,300	3,980	....	
Fall	10	7,500	6,820	....	
Rapids	6	8,000	4,360	....	
Rapids	6	9,000	4,910	....	
Kettle Falls	19	9,000	15,550	....	
Rapids	15	9,000	12,250	....	
Caribou Rapids	6	9,250	5,050	....	

PART IV.

GENERATION OF POWER.

At the present speaking, the only power developments operating in this district are located at Kenora, where the extensive hydraulic facilities of the Winnipeg River have for some time been partially utilized for power and lighting purposes.

The power being developed at the present time is as follows:—

Kenora Municipal Plant:—This plant, now in process of construction, is located at the eastern outlet of the Lake of the Woods, and is designed for an ultimate capacity of 4,000 H.P., half of which is to be installed immediately. Of this portion, 1,000 H.P. is already

contracted for, in addition to the municipal load of approximately 300 H.P. The conditions of the contract call for the construction of permanent works for full capacity of 4,000 H.P. and for the immediate installation of three units of 500 k.w. each. The power house and dam have already been completed and one unit put into service.

Lake of the Woods Milling Co.:—This company develops in the neighborhood of 2,000 H.P., water being taken from the Lake of the Woods by means of a flume.

Keewatin Flour Milling Co.:—This company has a 3,000 bbl. mill in process of erection, and will use about 1,500 H.P. of hydraulic power, for which a flume has been excavated and machinery installed.

As yet no active development has taken place on the main or western branch of the river, but some years ago, the Keewatin Power Co. constructed what is known locally as the Norman dam, across the western branch about 3-4 mile from the Lake of the Woods outlet.

The dam is constructed of rock fill, with heavy masonry sluiceway piers. Apart from a certain amount of leakage through the rock fill, the dam is in serviceable condition at the present time, and would admit the development of 20,000 minimum horse-power under present conditions.

At the present time the total average amount of power developed in the town of Kenora is in the neighborhood of 4,250 H.P., of which about 1,400 H.P. is the average amount of hydraulic power used direct, and 1,900 H.P. hydro-electric, the remainder, 950 H.P., being steam generated. Of this latter amount about 100 H.P. is available for electric installation.

As regards rates for power and light, the municipality charges 10 cents per kilowatt-hour for incandescent lighting and from $10.00 to $50.00 per horse power per year for power, this price being regulated according to the quantity contracted for.

At Fort Frances on Rainy River, the important international power of Koochiching Falls is being developed for the joint use of Fort Frances and the town of International Falls on the American side of the river. The natural head is about 23 feet. This will be increased to 27 feet when the power installation is completed. The estimated low-water capacity is about 16,500 H.P., and permanent works for full capacity are being constructed at the present time. At

the present speaking, there is no market for power in either town, but the prospect of much improved railway facilities in the near future is expected to supply, in conjunction with cheap power, sufficient inducement for the establishment of manufacturing industries. A large proportion of the power it is expected will also be used for grinding the pulp output of the district. The development provides for the construction of two power houses, one on the Canadian and one on the American side of the river. Each power house will ultimately contain nine 1,000 k.w. units, which will be installed as the occasion demands.

Investigation as to present and probable and future demands for power would seem to indicate that the requirements of this district will be amply met for some time to come by the above-mentioned installations, until such time as mining or milling operations warrant special developments.